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Assessing the Role of Artificial Intelligence in Cancer Treatment of Targeted Drug Delivery

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Abstract: Cancer is the one of the leading causes of death due to its high morbidity and mortality throughout the world. Various anticancer therapies like chemotherapy, radiation therapy, hormone therapy, surgical approaches etc. are widely used in treating cancer, but have serious adverse effects mostly due to cytotoxic action towards normal cells. AI is a boon in the field of oncology too. Anticancer drug activity is predicted using AI, and AI is used to help in the development of anticancer medicines. Various cancers and medications may react differently, and recent screening tools have repeatedly revealed a connection between cancer cell genetic variety and therapeutic efficacy. Its main features are lesion recognition, target area delineation, three-dimensional tumour localization, clinical and pathological analysis, quantitative tumour analysis, and tumour picture segmentation. The present review will cover the current status of various monoclonal antibodies used in targeted drug therapy of cancer along with the future prospects of therapy. This article highlights the application of AI in various facets of the pharmaceutical sectors with focus on cancer treatment.

Keywords: Artificial Intelligence, Machine Learning, Cancer, Chemotherapy, Radiotherapy, Monoclonal Antibodies.

1. INTRODUCTION

Artificial Intelligence has already become an integral part of our day to day lives and proposes to improve it further. Constantly increasing data volumes, improvements in algorithms and continuous evolution of computer power and storage are some of the major reasons for the popularity of AI. This concept of Artificial intelligence was rooted in early 1950s and was defined as the science of developing intelligent machines by one of the founders of this field, John McCarthy [1]. AI is the capability of machines to learn and simulate the tasks which are often related to human behaviour, it can also be described as a set of self-learning techniques [2]. AI is not a single technology but a cluster of various other technologies like Machine Learning (ML) and Deep Learning (DL) that are used separately or in a combination for completing the provided tasks. Machine Learning is a computational process which requires input data to achieve desired task [3].It comprises of a lot of theories and algorithms. Algorithms are nothing but a set of rules that creates a model. These

algorithms can be classified into supervised, unsupervised and reinforcement learning show in figure 1 [4].

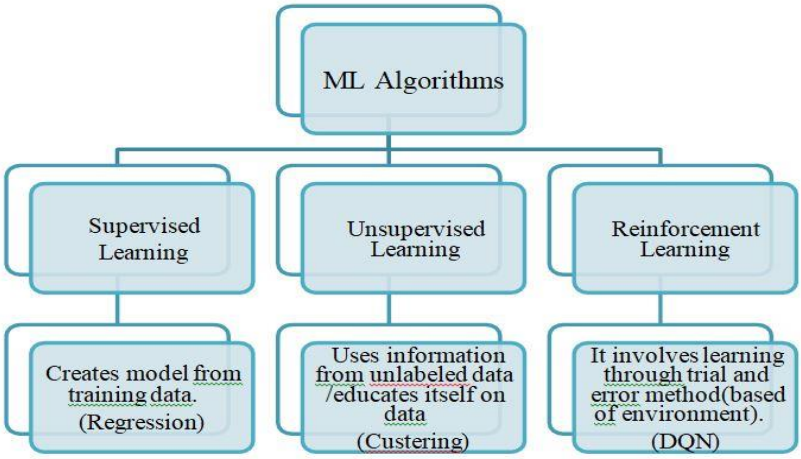

Fig 1.1 Classification of Machine Larning Algorithms

If any desired output is described by certain attributes then machine learning potrays and connects those attributes for achieving final results or desired output.

2. AI, Machine Learning and Deep Learning

Artificial intelligence is a concept that arises from an idea to use technology that will utilize behavior that imitate man (Figure 1). This idea gave rise to another recommendation called machine learning, which comprises of statistical strategies to understand by being specifically programmed, it can also be understood in cases where programming is unknown [5].Machine learning incorporate supervised learning (Observed and directed planning), unsupervised learning (un-Observed and in-directed planning) and reinforcement learning (supportive planning). Supervised learning is the determined method, it encompasses regression methods along with classification methods where prognostic models is framed based on data from the input and the output sources. The classification sub-section output implies illness identification, the regression sub-section identifies efficacy of the drug and absorption, distribution, metabolism, excretion and therapeutics prediction. Unsupervised learning is the un-determined method, which takes into consideration, grouping and characterizing approaches based on inputs [6,7]. As per this concept the output identification (sub-section to illness) can be identified from the grouped inputs and target identification can be done by the characterized inputs. Reinforcement learning is practiced by the ideology of composing decisions in specified circumstances and enforce them to augment performance. The output of this is de novo drug design which Is a part of making decision and experimental designs under the enforcement or execution. These all are achievable by modeling and quantum chemistry [8].

Machine learning is further sub classified into another aspect which utilizes machine-made neural networks which learn from huge experimental data, this is called as machine learning. The huge database gives more probability to the chances of discovering new molecule that can in turn be a novel drug for a disease or disorder [9]. As the technology is advancing, new methods of data management aids in handling huge data and synchronizes the concept of ML. The concept revolves around neural networks and its sub types like conventional, recurrent, and fully connected feed-forward networks. This idea will give rise to an era of successful clinical trials with negligible errors and maximum achievable efficiency with fastest possible speed and economical process [10].

Another important methodology or element of AI is deep learning (DL). DL projects the input data towards the output by utilizing representation learning or feature learning. This conversion process takes place inside a cluster of numerous mathematical processing units also known as neurons. These neurons derives a logical relationship between the input and the output with the help of forming Deep Neural Network (DNN) [11]. It is evident that the representation of data by deep learning provides better results as in better sample generation and better classification modeling and it also enables the automated extraction of depictions from the unsupervised data.(Fig.2)

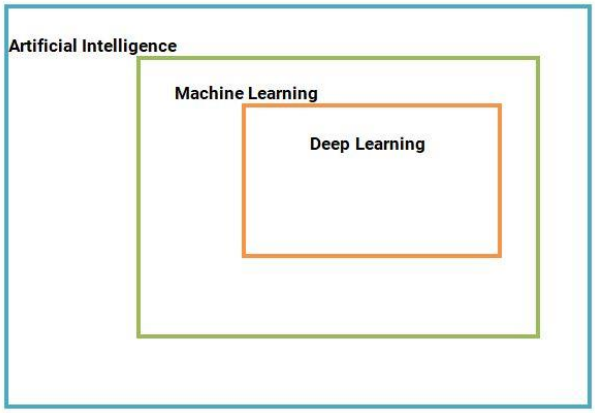

Fig 2.1 Relationship between the AI, ML, DL

In the current scenario AI has revolutionized almost all the facets of the healthcare industry including drug discovery, diagnosis of complex diseases, patient care and monitoring, assisting experts in decision making and so on. In the same way, AI is playing a crucial role in oncology too [12]. The way to reduce the mortality rate due to cancer is early detection and treatment. The utilization of AIs complex algorithms can help in accessing the patient's relevant clinical information so that any type of inaccuracy in diagnosis or treatment can be avoided. Neural networks and deep learning also provides genetic analysis and detection data which makes it easier to analyze the treatment outcome. Similarly the application of AI in radiomics allows easy enables the accurate diagnosis of complex malignant tumors which otherwise cannot be detected by the human eye [13].The clinical oncologists obtain the image of tumor sites and with the help of certain software outlines the tumor for providing the radiotherapy dose, AI helps in marking these spots and margins so that the therapy acts at site and prevents potential unnecessary side effects. It also allows the experts to identify organs at risk to be more accurate and protecting them from side effects. This process is called radiotherapy target delineation or contouring which can be performed precisely with the application of AI technologies [14].Deep Neural Network (DNN) can also support classification of cancer subtype by using the medical images. One of the important elements of cancer detection is determination of the stage. The stage decides the kind of therapies or treatments to be given to the patients. Gleason score (merger of two scores indicating the presence of tumor at two different locations in the body) is a component that aids determination of stage in the prostate cancer. DNN has proved to give promising results in calculating the Gleason score by using histopathological images of tumors. AI has opened new ways for early diagnosis of cancer via various novel detection techniques like liquid biopsies for circulation tumorDNA (ctDNA). This technique involves minimal invasion in the body (detectin by blood samples) and allows tracking of possible risk of relapse and predicting the appropriate treatment options. Along with early detection as seen in the above examples, the AI also serves other purposes like identification of key mutations by utilizing the histopathological images and detecting the origin of tumors for providing effective chemotherapy to the patients [15].

The cancer research, drug discovery and development costs excessive money and time making the cancer treatment really expensive, it's very essential to make it affordable and accessible to common people. Involvement of AI plays key role in making this process more efficient. This is somehow achieved by integrating various sets of data for example integration of clinical data and gene expressions, and thus inscribing all the components of drug discovery process. Along with its application in discovery, AI is also applied in drug designing for generation of new molecules(in silico) consisting specific properties and target affinities, though there are certain problems and difficulties in modeling complex targets and certain specific objectives but still it helps serving the purpose [16]. One of the examples is designing of structural analogue of celecoxib and sulfur less compounds (Fig .3)

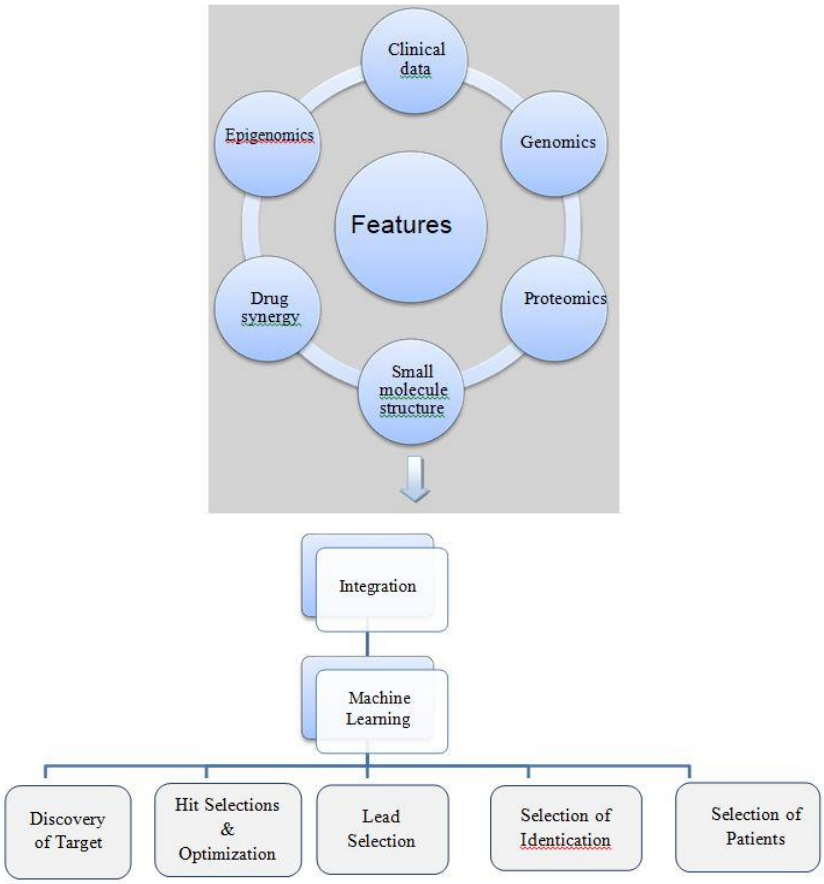

Fig 3.1 Integration of Various Datasets to Support Stepwise Drug Discovery

3. Drug Development Process

The data is available from various substantial sources. The derivation can be from high-degree efficiency compound and fragment screening, computer modelling and literature sources. These multifactor variables are used to commence the feedback-driven drug development process. Inductive and deductive analysis are a vital part of this process. These are used for optimization of the identified hits and also the lead compounds. Drug development process has several components and their automation leads to substantial decrease in the unpredictability and probabilities of errors, which in turn enhances the efficiency of the process. Design method such as De-novo, takes comprehensions of organic chemistry for synthesis of in-silico compounds and virtual screening of models [17]. This in-turn gives a place to efficacy and toxicity analysis of biochemical and biological parameters. These algorithms enables invention and identification of novel compounds with various anti-disease activities. The fundamental step is to identify the novel compounds which comprises of a promising biological activity. Biological activity denotes to interaction of the compound to the organism as whole or it can even limit to an enzyme. When a compound exhibit a promising biological activity to a target that it is considered as a 'hit'. Chemical libraries, compounds isolated from plant, fungi, bacteria etc naturally and computer simulations can be screened to identify the hits. Once the hits are identified then the further step is the recognition of the lead molecule. The lead has the possibility to be the new drug for a disease treatment. The lead is then optimized on the basis of the chemical structure, alterations are done to get a compound which gives more efficacy, safety and therapeutic benefit. The compound is characterized for its safety and efficacy on animal models or cell based assays [18]. The implications of artificial intelligence during multiple stages of cancer therapy with the challenges are summarize in table no 1.0. [19].

Table 1: Implications of AI during Multiple Stages of Cancer Therapy.

	OPPORTUNITIES	**CHALLENGES**
DISCOVERY	Minimize off-target effect & toxicity and enhance drug exposure	Identifying optimal targets and properly validating AI-designed drugs.
DEVELOPMENT	Optimize drug & dose selection and match patients to therapies and trials.	Improving trial outcome and stratification with the right patient data.
ADMINISTRATION	Sustained dose optimization. Overcoming resistance with game theory.	Moe clinical validation needed. Use in more cancer types.

3.1 Role of AI in Chemotherapy

Artificial Intelligence can widely apply during the course of chemotherapy, focusing majorly on the patient's response to drugs. There are many milestones of implications of artificial intelligence achieved by the researchers in the cancer treatment. As of now, researchers claim that AI can successfully use to optimize and manage the overall chemotherapy and drug tolerance. Guocai Chen, *et al.,* used stacked RBMs deep learning method to predict the synergy of drug regimen or drug in combinations carried in by patients during the chemotherapy. Out of many effective ways the synergistic effect caused by the combination of drug is one of the most advantageous properties known for the treatment of cancer. Although the desirable synergistic effect was challenged by the prediction of drug combination which is effective. Drug synergy was predicted using gene expression, pathway and Ontology fingerprints, which are the literature derived ontological profile of the genes, a method which is novel in the scope of chemotherapy and is based on deep belief network [20]. Using deep belief networks we can create a fairly decent framework to capture predictions despite comprehending the underlying mechanisms, if we have enough, well-annotated data for training. This enables us to extend the present model to include more types of data, such as mutation, mythylation, and proteomics data. Because of its scalability, we can improve the sustainability of our technique by including data collected in the future.

Mark N. Levine *et al.,* applied AI to the electronic health record (EHR) so as to maintain the well timed data of the effect of chemotherapy on patient's outcomes. The EHR helps the doctors and clinician to have the insight of the real-world patient experience, either good, bad or some troublesome ADR. The AI was applied on the extracted data from the EHR after it was imported into the IBM cloud [21]. Data was retrieved from the EHR of patients with stage III breast cancer who presented between 2013 and 2015, de-identified, and put further into the IBM Cloud. Medical concepts were extracted from unstructured clinical literature and transformed into structured attributes using specialised natural language processing (NLP) annotators. These annotators were tested on 19 more patients with stage III breast cancer within the same time period during the validation phase. For nine critical indications, the generated data was compared to that in the medical chart (gold standard).To examine the patient journey, data from the EHR can be extracted, read, and combined. The degree of correlation among NLP and the gold standard was found to be high and significant, indicating that it was legitimate.

Allan J. Pantuck *et al.,* used an AI platform named CURATE.AI for the optimization of combination chemotherapy thus applying synergism as an curative and effective way for the treatment of cancer. ZEN-3694 and enzalutamide, the two drugs were used in combination during the study.CURATE.AI was found to identify significant dose modifications for ZEN-3694 and enzalutamide, improving efficacy of treatment and tolerance. It additionally indicates that ZEN-3694's involvement in the regimen is responsible for the patient's long-term response. The patient was likely to progress with the combined treatment because of the CURATE.AI's improved safety and effectiveness, leading to a sustained response and no tumor progression based on CURATE. PSA levels were kept under control by AI, and the size of the lesion was reduced. The introduction of technological platforms like CURATE.AI has made it possible to modulate combination therapy dose in order to improve therapeutic efficacy and maintain patient tolerance.These qualities could help to enhance crucial clinical trial results like objective response rates and overall survival, among other things. CURATE.AI was able to individualise ZEN-3694 and enzalutamide delivery in combination in this study due to dose adjustments in a patient, receiving combination therapy for mCRPC [22].

3.2 Role of AI in Radiotherapy

In the radiotherapy for the treatment of cancer the role of Artificial Intelligence is quite specific. Radiotherapy includes mapping out the target regions to cure them via radiations. Artificial Intelligence was found to assist the radiotherapy, from targeting the affected region to define the specific radiation for the same [23]. In general the radiotherapy for the treatment of cancer consist of 7 different stages imaging, treatment planning (TP), simulation, radiotherapy accessories, radiation delivery, radiotherapy verification, and patient monitoring [24].

The first step in the radiotherapy is imaging, which is diagnostic stage for the presence of tumor. The detection of tumor leads to collection of information. The process of imaging delivers the gross volume of the tumor, its location size and information about its vicinity. Due to the implication of AI presently there are many modals for the imaging of tumor, like Poistron Emission Tomography (PET), Single photon emission tomography (SPECT), Computed Tomography (CT).The TP & simulation process are intended to obtain the data of patient under recovery which mainly often includes mass of the tumor, patient's body weight, height, BMI, pre exposures to any treatment. All the details are noted and calculated so as to obtain the best outcomes. As the name itself suggests, treatment planning (TP) includes risk and failure estimation, optimization of treatment planning, beam intensity shaping etc. [25].

To immobilize the patient under treatment radiotherapy accessories are used and then the radiations are delivered. The main target of the ionizing radiations is to destroy the tumor cells while safeguarding the healthy cells. The current radiotherapy modalities include stereotactic body radiotherapy (SBRT), proton therapy, electron therapy etc. After the successful delivery of radiotherapy the patient is followed for the period of months to years, so as to make sure his wellbeing after the exposure of the therapy i.e patient is monitored.

Li Lin *et al.,* studied and constructed a deep learning tool for the contouring of primary gross tumor volume in patients with Nasopharyngeal Carcinoma (NPC). The use of Artificial Intelligence in the treatment of patients under study, made the treatment accurate and precise, this could be seen to have a fruitful impact in controlling and reducing the tumor and in the survival of patient. Babier *et al.,* used deep learning to develop a software which offers time reduction in the course of radiation therapy from days to just few hours [26, 27].

The switch from traditional AI to deep learning algorithms of modern AI requires as much data as possible. As the novel AI is helping out to produce automated regimens for the cure, data sharing becomes necessary with the guarantee of patient's privacy. This need became the root of growing IT infrastructure promoting data sharing [28, 29].

The manual delineation of targeted area before AI takes 4-5 hours, while automated delineation after the implication of AI in radiotherapy takes 15-20 minutes, thus the use of AI mainly focuses on targeting the cancer affected area, and the formation of an automatic radiotherapy plan. The AI plays its role effectively without the hustle of manual image extraction, registration & interpolation. In manual radiotherapy treatment of some organs requires doctor to manually change the location after the result is generated. Also as the AI offer treatment planning (TP) it becomes easier for doctors to take a follow up and thus AI accelerates the overall treatment duration [30].

3.3 Role of AI in Cancer Drug Development

The application of AI is not limited to diagnosis but these technologies are actively applied in anticancer drug development too. One of the most important factor in drug development is determining the interaction between drugs and cancer cell genome. Many scientists have worked in this direction of utilizing machine learning for identifying accurate interactions. Lind *et al.,* amalgamated machine learning technology with the screening data , which resulted in a forest model for forecasting the action of the antitumor drugs as per the mutation state of the cancer cell genome [31]. In a similar way Wang and friends created a machine learning based prediction model that was known as elastic regression model that successfully forecasted the sensitivity of the patients suffering from ovarian cancer, gastric cancer and endometrial cancer who were treated with tamoxifen , 5FU and paclitaxel respectively. AI can also easily help in assessing how the tumor cells acquire resistance towards cancer drugs by analyzing the large datasets [32, 33].

Development of a drug is a tedious process which requires a lot of time and a huge sum of money. Many of the developed molecules are rejected in the clinical trials due to certain toxicity vrelated problems or other issues. AI in various forms can reduce the intensity of these factors and make the drug development process less tedious and economic. Virtual screening of molecules is a very promising process which involves identification of the potential molecules from millions of different compounds. The association of machine learning and high throughput screening may easily reduce the cases of false predictions [34]. In technologies, the researchers adopt the most complex and effective algorithms to perform this screening, such as SVM, Bayesian, deep neural network RF etc. Xie *et al.,* used SVM along with docking based method while meslamani *et al.,* describes the use of PROFILER for determining which of the ligands have the highest probability for combining with bioactive compounds [35, 36]. The precision medicine is a rapidly evolving strategy for disease management. This allows the experts to create personalized and more accurate treatment plans for the patients by analyzing their genetic profiles, type of tumor and other medical records. Assessment of such a huge dataset and drug discovery is again supported by AI technologies. These are the various approaches where AI supports development of cancer drugs making the process more efficient and economic.

3.4 Role of AI in Immunotherapy

Immunotherapy is one of the most critical therapies of all the treatments adopted for the treatment of cancer. It involves curing cancer by activation patient's own immune system or defense system by utilizing the substances either made by the body or in laboratory. This therapy is proved to be really effective in treating different types of cancer, yet there are certain limitations of this therapy including high cost and frequent adverse effects (auto immune disorders) in patients. Application of the AI can make this therapy more efficient by elevating diagnosis accuracy, reducing human resource costs, predicting the outcome of the treatment beforehand with the aid of medical imaging, immune signatures and histological analysis.It is evident that AI enhances the success ratio of immunotherapy by forecasting the outcome of therapy in patients with the help of immune predictive scores like immunophenoscore and immunoscores. The identification of major histocompatibility complex (MHC) by AI technologies renders 99.66 % accuracy in recognition of patterns related with immune response. So in a nutshell it's evident that the combination of AI algorithms and clinician's interpretations may lead to better results for patients [37, 38].

The advancements in immunotherapy are often subject to identification of targets that are connected to development of resistance against tumors or tumor causing factors, hence AI is of great use in broadening the applicability of immunotherapy in treating cancer. A large number of samples and assays are required for effectively analyzing the interaction of tumor cells and immune cells along with patient's response to this interaction, these assays in return generates huge amount of data sets that are quite difficult to scrutinize manually, AI supports easy and quick investigation of large datasets. The presentation of peptides that binds with the MHC is important for development of cancer vaccine, thus machine learning has been implemented in recognition of neoantigens presented by the solid tumors[39]. The recognition of neoantigens properly requires screening of a large number of synthetic peptides and difficult to acquire clinical specimens or human leukocyte antigen (HLA), B. Bulik Sullivan *et al.,* evolved an AI method involving deep learning that uses tumor HLA peptide mass spectrometry datasets for enhancing neoantigen recognition [40].

4. Monoclonal Antibodies (mAbs) used in Cancer Treatment

Monoclonal Antibodies in the treatment of cancer have been established as a milestone around various pre-existing therapeutic strategies. Comes under immunotherapy the monoclonal antibodies are now considered as one of the most effective element for the cancer treatment [41].

Monoclonal antibodies are featured to have a specific and common antigen binding site in all the antibodies produced homogeneously from a single cell line. Thus, all the antibodies produced are identical in their protein sequence and have same affinity and biological interactions [42].

Antibodies are potent enough to elicit the later immune response, by first recognizing the foreign antigen and then neutralizing them. Structurally antibodies are glycoproteins and belong to Ig (Immunoglobin) superfamily. In the structure of antibody the fragment - antigen binding (Fab) region as its name suggest is for the identification of the specific antigen. Another region which is located

downside the Y structure of the antibody, name as the fragment crystallizable (Fc) region is responsible for the interaction between antibody and other elements of the Immune system. These Fc regions are identified by Fc receptors (FcRs) present on the immune cells. Based on the heavy chain, there are five types of antibodies exist, namely IgM, IgG, IgA, IgD and IgE. Among them the IgG is most common antibody that is used in immunotherapy and antibody therapy [43,44].

5 MOA of mAbs

The monoclonal antibodies can effectively cause cancerous cells death by various known mechanism. The very first and head-on mechanism known is the blocking of growth factor receptor (GFR) signaling. When mAbs binds to the target GFR while controlling their activation and ligand binding state then eventually the growth of tumor unsettled. One very fine example of mAb drug that follow this MOA is Cetuximab, which is an anti-epidermal growth factor receptor (anti-EGFR) monoclonal antibody. The overexpression of EGFR in cancer cell eventually leads to tumor cells multiplication and migration, Cetuximab initiates apoptosis in tumor cells by blocking the ligand binding site and dimerization of the growth factor. [45].

Another mechanism involving the growth factor, follows internalization; a type of endocytosis because the growth factor has no ligand and thus they follow hetero dimerization for their activation. One such growth factor is Human epidermal growth factor receptor 2 (HER2) is tyrosine kinase receptor which overexpressed in breast and ovarian cancerous cells.Monoclonal antibodies treat such cancerous cells by inhibiting hetero dimerization and internalization. The first FDA appovedmAb was Trastuzumab, an anti-HER2 which still remain an effective treatment for breast and ovarian cancer.

Apart from the two mentioned direct mechanism, there are various indirect mechanism also exist which need the element of host immune system to function, namely compliment dependent cytotoxicity (CDC), antibody dependent cellular phagocytosis (ADCP), and antibody-dependent cell-mediated cytotoxicity (ADCC). Table 2 summarizes FDA approved mAbs [46].

Regardless of the fact that monoclonal antibody treatment has had some remarkable clinical achievements, therapeutic resistance still poses a major barrier. Additional study should concentrate on examining the mode of action of mAbs in order to find novel ways to improve clinical efficacy.

Table 2: Monoclonals Antibodies Approved by FDA for Cancer Treatment.

NAME	**ANTIGEN**
Atezolizumab	PD-L1
Avelumab	PD-L1
Bevacizumab	VEGF
Cemiplimab	PD-1
Cetuximab	EGFR
Daratumumab	CD38
Dinutuximab	GD2
Durvalumab	PD-L1
Elotuzumab	SLAMF7
Ipilimumab	CTLA-4
Isatuximab	CD38
Mogamulizumab	CCR4
Necitumumab	EGFR
Nivolumab	PD-1
Obinutuzumab	CD20
Ofatumumab	CD20
Olaratumab	PDGFRα
Panitumumab	EGFR
Pembrolizumab	PD-1
Pertuzumab	HER2

Ramucirumab	VEGFR2
Rituximab	CD20
Trastuzumab	HER2
Gemtuzumabozogamicin	CD33
Brentuximab vedotin	CD30
Trastuzumab emtansine	HER2
Inotuzumabozogamicin	CD22
Polatuzumabvedotin	CD79B
Enfortumabvedotin	Nectin-4
Trastuzumab deruxtecan	HER2

6. Future Prospects

Currently the applications of AI in oncology are vast and wide spread. Though the major challenges and questions in oncology including analysis of large amount of data, lack of early diagnostic techniques, difficulty in implementing patient treatment plans, drug development etc are efficiently combated and answered by AI technologies to a large extent , still there are many more obstacles at the ground implementation level that are needed to be managed yet. The certain areas that requires to be addressed to avoid pitfalls includes building of cancer AI research communities, access to quality cancer data, black box problem(lack of rationale in predictions made by machines) etc. Also in order to get complete benefits of AI it is very important to fill the knowledge gaps , today the clinicians are least informed about data science and technology , in a similar way the tech experts are least informed about the field of oncology ,bridging this gap will definitely lead to utilization of AI to its maximum potential. It is evident from many studies that in the coming years AI will be incorporated in the clinical decision making, care, and diagnosis of cancer patients in a much more advanced manner. Cancer diagnostics is a traditional starting point for developing effective therapeutic methods and management of diseases, and its AI-based refinement is a significant success. Moreover, future AI innovations should take into account undiscovered but critical boundaries in this scenario, such as medication discovery, therapy administration, and follow-up tactics. Indeed, the expansion of AI, as per our viewpoint, needs to follow thorough and integrative patterns in order to determine a substantial improvement in the diagnosis treatment of cancer patients. This is among the most significant benefits of AI, as it will allow for the proper interaction and amalgamation of domains related to cancer on a single patient, enabling the difficult goals of personalized therapy.The ability to combine various and composite data produced from multi-omics techniques to oncologic patients is among the most promising AI expectations. AI's potential tools may be the only ones capable of handling large amounts of data from many sorts of analysis, such as information collected from DNA and RNA fingerprinting. In this vein, the recent publication of the American College of Medical Genetics' criteria and recommendations for the interpretation of sequence variants has sparked a new generation of AI development, with new possibilities in precision oncology.

At present work is needed to ensure the consistent implementation of AI in medical institutions and hospitals. Many experts believe that AI technologies holds massive potential to take oncology , cancer research and patient care to another level and combating challenges by continuous research and study will boost this potential further.

7. CONCLUSION

AI have certainly made some significant contributions as far as cancer research and drug development is concerned. We can't deny the fact that human brain is restricted in many ways making it difficult to discover and formulate the most appropriate treatment along with identification of minute details. This may deprive the patients from getting the best possible treatment and care. AI plays the key role here, it provides the experts and clinicians with a perception which otherwise would be very difficult to obtain. AI technologies have enabled us to make cancer research and drug development more efficient and economic. It has also contributed in speeding up the cancer drug discovery process, and precision drug discovery making the patient care more effective. Though there are still many challenges needed to be addressed for more unprecedented advancements in the field. More research and studies are required to take complete advantage of these AI technologies but it is very certain that integration of AI will be the driving force for the future advancements in cancer

research and will bring about promising changes in the existing technologies. Talking about integration, the most significant challenge for completing the 'AI-revolution' in oncology, are the creation of integrative and interdisciplinary research formative beliefs, the prompt understanding of the relevance of all malignancies, including rare tumours, and the continuous support for ensuring its growth.As discussed in this article, AI is having an increasing impact on every domain of oncology. The initial steps in establishing new development strategies with practical implications are to understand AI's historical background and current successes. AI is currently have been used in oncologic clinical practise, but continued and increased efforts are required to allow AI to reach its full potential.

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Conflicts of Interest
The authors declare no conflict of interest.

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